Observational Signatures of Magnetic Reconnection in the Extended Corona

Sabrina Savage[1], Matthew J. West[2], Daniel B. Seaton[3], Adam Kobelski[4]

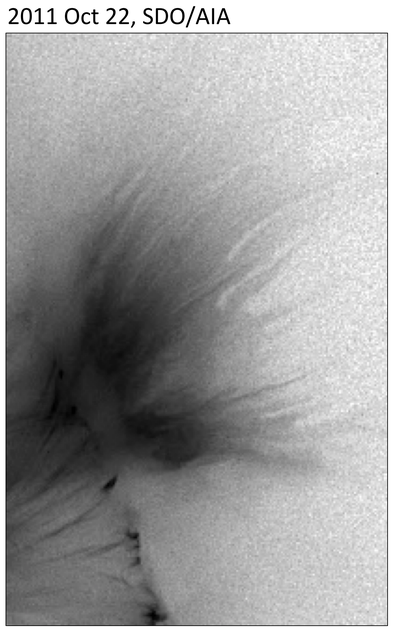
[1] *NASA Marshall Space Flight Center, Huntsville, AL, USA*, [2] *Royal Observatory of Belgium, Brussels, Belgium*, [3] *University of Colorado, Bolder, Colorado, USA*,
[4] *University of Alabama-Huntsville, Huntsville, AL, USA*

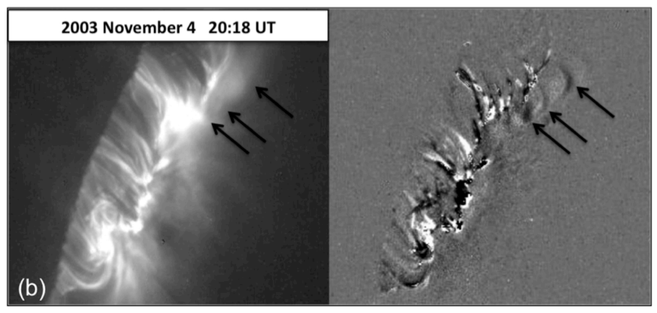
Abstract

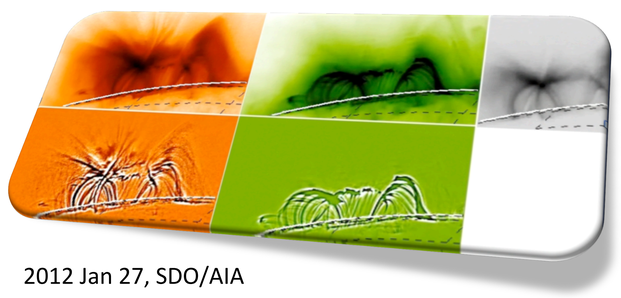
Observational signatures of reconnection have been studied extensively in the lower corona for decades, successfully providing insight into energy release mechanisms in the region above post-flare arcade loops and below 1.5 solar radii. During large eruptive events, however, energy release continues to occur well beyond the presence of reconnection signatures at these low heights. **Supra-Arcade Downflows (SADs)** and **Supra-Arcade Downflowing Loops (SADLs)** are particularly useful measures of continual reconnection in the corona as they may indicate the presence and path of retracting post-reconnection loops. SADs and SADLs have been faintly observed up to 18 hours beyond the passage of corona mass ejections through the SOHO/LASCO field of view, but a recent event from 2014 October 14 associated with giant arches provides very clear observations of these downflows for days after the initial eruption. We report on this unique event and compare these findings with observational signatures of magnetic reconnection in the extended corona for more typical eruptions.

Observations in the Lower Corona (< 1.5 $R_\odot$)

2011 Oct 22, SDO/AIA







2012 Jan 27, SDO/AIA

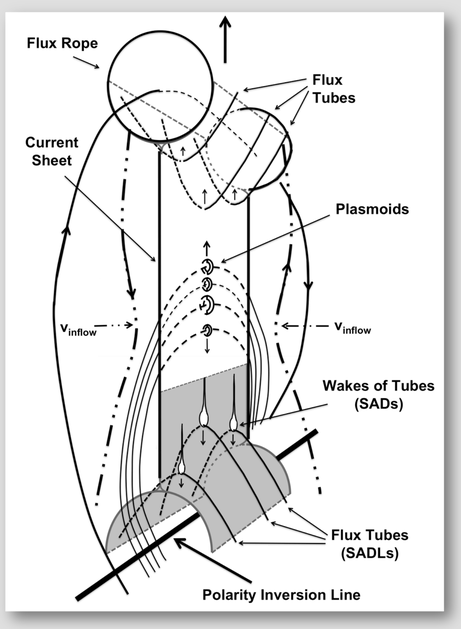
SADs and SADLs are features observed during Long Duration Events.

SADs appear as teardrop-shaped voids, discovered with Yohkoh, traveling sunward through the bright, hot fan extending outward along the spine of developing post-flare arcades. The voids are observed with high-temperature instrumentation (EUV, X-ray) & white-light coronagraph (density).

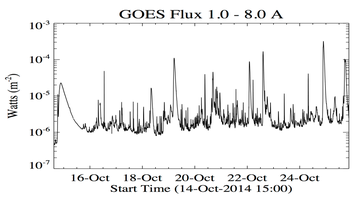
SADLs are a complementary observation, seen in the same region with the same trajectory profiles. These shrinking loops were first well observed with TRACE and have since been detected with Hinode/XRT and SDO/AIA.

Evidence suggests that SADs are a consequence of SADLs retracting through the plasma sheet, leaving behind disturbed regions of depleted density in the form of the voids**.

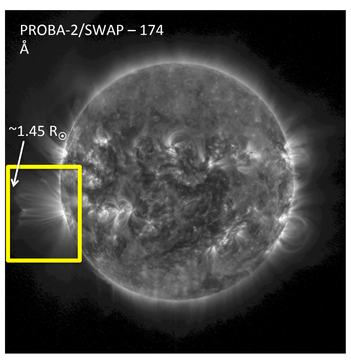
Basic 3D Reconnection Scenario



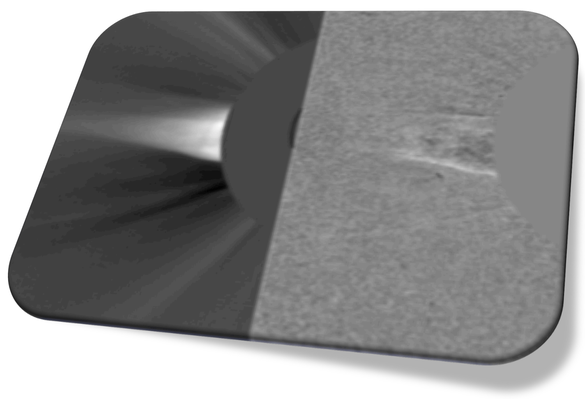
Observations in the Extended Corona (< 5 $R_\odot$)



"Giant Arches Flare" 14 Oct 2014



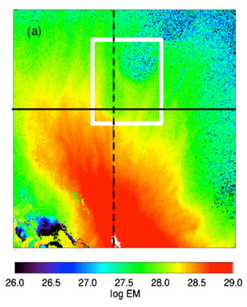
2010 Nov 3, SOHO/LASCO

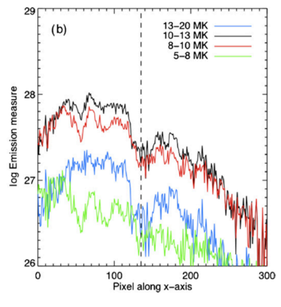


Voids and loops were previously reported** ~10 years ago and have seen in LASCO for several more recent flares as well, hours after the initial event, but this region has not had a lot of attention due to signal processing constraints. However, In the extended corona, we are better able to observe the migrating reconnection sites instead of well after the reconnection has occurred. Now that we have clearer observations and understanding of these features in the lower corona, it is timely to refocus on the extended corona.

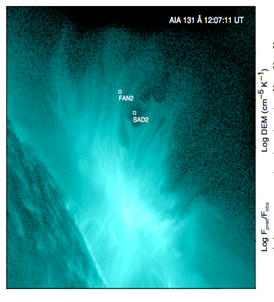
The "Giant Arches Flare"** is a prime candidate for probing continued energy release. This extremely long duration event may be the clearest example of continual reconnection in the outer corona in the wake of a coronal mass ejection to date.

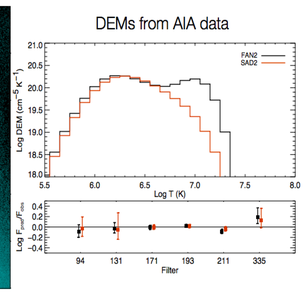
Post-arcade loops extend beyond 1.5 $R_\odot$, and both SADs and SADLs are present for at least 5 days after the initial eruption with observable initiation sites beyond 5 $R_\odot$.

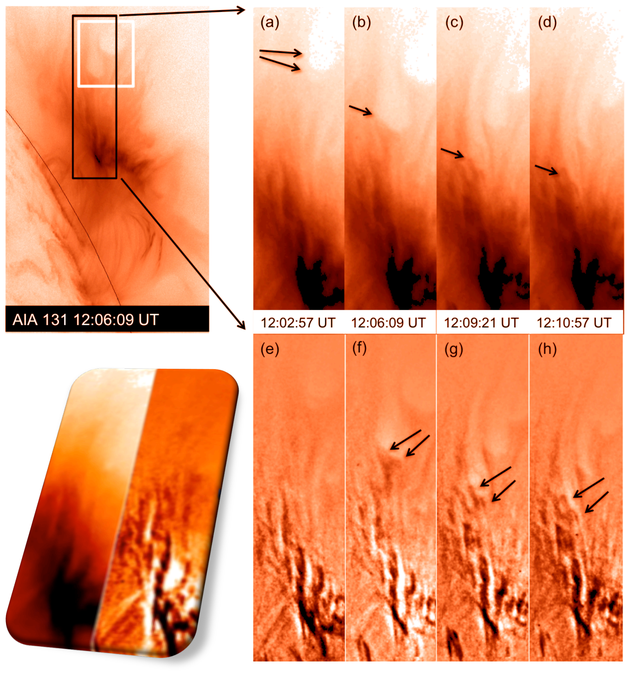




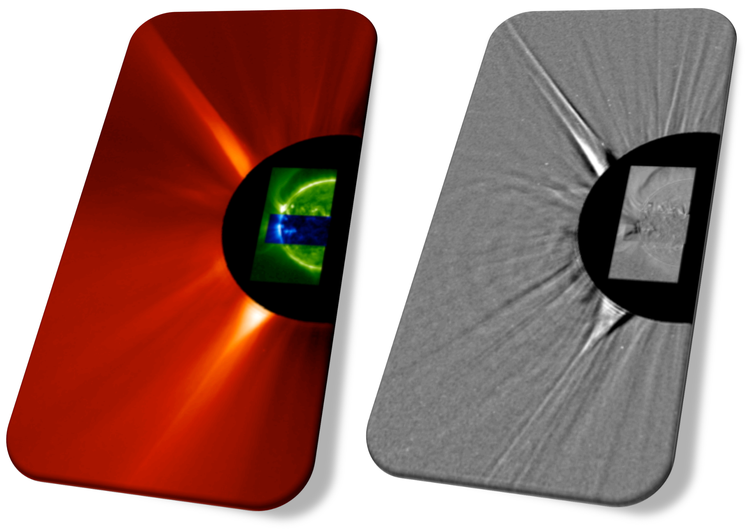
OBSERVED TEMPERATURE AND DENSITY ALWAYS LOWER THAN FAN

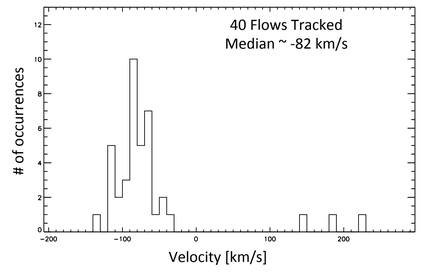


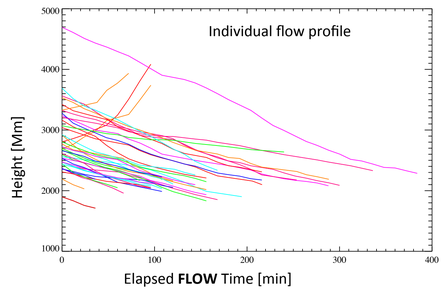




2014 Oct 14, SOHO/LASCO, PROBA-2/SWAP, SDO/AIA







References: Hanneman & Reeves 2014, McKenzie & Savage 2009, Ohyama & Shibat 2008, Savage et al. 2010, Savage et al. 2011, Savage & McKenzie 2011, Savage, McKenzie, & Reeves 2012**, **Sheeley, Warren, & Wang 2007, **Sheeley & Wang 2007, **West & Seaton 2015